Effect of Noise upon the Perception of Speech Intelligibility in Dysarthria

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BACKGROUND

- Recent studies in dysarthria have examined the role of the listener in the communication process [1-2]; though listening has been examined under optimal conditions.
- In daily life, events occur in sub-optimal listening conditions – noise may negatively affect a listener's ability to process the speech signal during communication exchange.
- Normal speech intelligibility is adversely affected by noise [3], with greater effects observed when speech is artificially distorted by time compression and reverberation [4].
- Preliminary research has further indicated that dysarthric and normal speech may be differentially affected by background noise [5]. Further examination of this potential effect is required.

RESEARCH QUESTION

- Is the intelligibility of dysarthric speech, at word and phrase-level, affected similarly to normal speech when presented in noise? *It is hypothesised that dysarthric speech will show greater declines in intelligibility with increased noise than normal speech.*

METHOD

- **Listeners:** Twenty undergraduates, 19 females and 1 male with a mean age of 20 years (SD= 2.5 years).
- **Procedure:** Two experiments were conducted with order counterbalanced across listeners: (1) *Word level intelligibility* using a forced choice paradigm (four choices) and (2) *Phrase level intelligibility* via orthographic transcription.
- Both experiments included four conditions: no noise (NN); +6 dB signal-to-noise ratio (SNR); 0 dB SNR; and -3 dB SNR. Listeners completed the task in a quiet room while wearing high-quality headphones. Presentation order was blocked to ensure that no listener heard the same stimuli more than once.
- **Noise:** Multi-talker babble was presented in conjunction with the speech stimuli.

METHOD CONT

- **Speech stimuli:** Obtained from three adult males with dysarthria and three age-matched controls (see Table 1). Stimuli collected included: (1) 72 words from the single-word intelligibility test of Kent et al. [6] and (2) Phrases derived from the Assessment of Intelligibility of Dysarthric Speech .
- **Reliability:** Mean intra-participant reliability was calculated for word intelligibility data. Twenty percent of the data set was repeated. Results indicated that r=0.51 , p<0.001. Inter-listener reliability was 0.73 (Cronbach's alpha).
- **Statistics:** Two mixed between-within subjects ANOVAs were conducted to explore the effects of speaker group (dysarthric versus control) and noise condition (no noise, +6 dB SNR, 0 dB SNR, and -3 dB SNR) upon intelligibility in the word-level and phrase-level experiments. Post hoc analysis was conducted using pairwise multiple comparisons.

Table 1: Characteristics of the dysarthric speakers.

Speaker	Age	Time post-injury	Dysarthria diagnosis
1	58	39	Severe spastic-ataxic
2	52	32	Moderate ataxic
3	35	16	Moderate-severe spastic- flaccid-ataxic

RESULTS

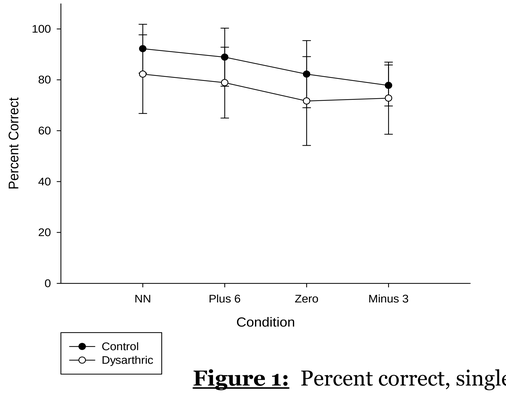


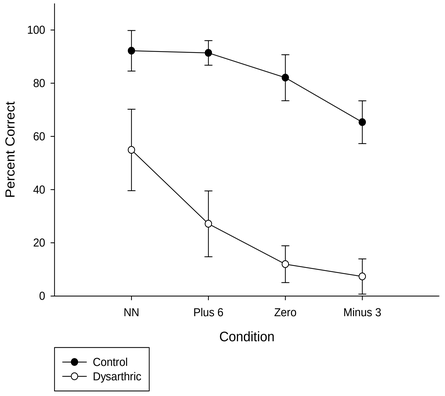
Figure 1: Percent correct, single word forced choice .

- Significant main effects were observed for Group (F=22.87, p<0.001) and Condition (F=8.71, p<0.001). However, there was no interaction effect (F=0.55, p=0.65)

RESULTS CONT

- Significant main effects observed for Group (F=1044.42, p<0.001) and Condition (F=138.61, p<0.001), and a significant interaction (F=19.60, p<0.001).
- Primary post-hoc finding: A significant reduction in intelligibility between the NN and +6 SNR condition for the group with dysarthria (t=6.81, p<0.001).

Figure 2: Percent correct, phrase level.



DISCUSSION

- Results confirm prior research suggesting that listeners' perceptions of speech intelligibility in dysarthria is affected differently to normal speech when presented in noise [9].
- At phrase level, the intelligibility of dysarthric speech was adversely affected compared to normal speech in relatively low noise conditions (i.e., +6 SNR). Therefore, it is likely that speakers with dysarthria are required to significantly increase their effort levels when communicating in sub-optimal listening environments.
- Future research should aim to examine the underlying reasons for the differential effects upon the listener in noise – e.g., contributions of acoustic parameters and cognitive linguistic processing.
- Investigation of speaker adaptation to differing acoustic environments is also required.

ACKNOWLEDGEMENTS: New Zealand Neurological Foundation Small Project grant 0533-SPG, members of the TBI support group, Canterbury Branch, Brain Injury Association of New Zealand, and listener participants.

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